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METHOD FOR PRODUCING A FLAT STRIP

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to a method for producing a flat strip in which a reinforcing fiber fabric, comprised of a multitude of parallel aligned reinforcing fibers interwoven with cross fibers, is embedded in a binder matrix made of synthetic material.

Description of the Related Art

Reinforcing strips of this type are known for example from WO96/21785. These reinforcing strips are employed on longitudinally extending and/or planar building components. The reinforcing lamella comprising a duroplastic (thermosetting) plastic as binder matrix, in particular an epoxy resin, do not allow for formation of bends with small bend radius, so that it is not possible to herewith form angular reinforcements extending over a construction component edge. Angled reinforcements are needed for example for a steel reinforced concrete beam or a steel reinforced concrete T-beam to reinforce the area between the pressure and tensile zone and to avoid thrust and transverse tears.

The invention is based upon the task of developing a process for manufacture of flat-strip bands, which makes possible a particularly rational manufacture in a continuous process.

SUMMARY OF THE INVENTION

The inventive solution is based upon the concept, that a particularly rational manufacturing method is possible in the case that a thermoplastic synthetic material is used as binder matrix.

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A first alternative solution envisions that a film of thermoplastic material is pressed against at least one broad side of the support fiber web, that the thermoplastic material of the film is caused to melt under the influence of heat, that the support fiber material is impregnated with the melt of the thermoplastic material under the influence of pressure and that the thermoplastic material is subsequently cooled while maintaining pressure to form the hardened binder matrix.

In accordance with a preferred embodiment of the invention the support fiber web and the at least one thermoplastic film are pressed, heated and cooled in one continuous process. The support fiber web and the at least one thermoplastic film are thereby preferably drawn off of supply rolls and pressed, heated and cooled along a pass-through segment. Herein the support fiber web is preferably conveyed to the pass-through segment in the longitudinal direction of the support fibers.

A further advantageous embodiment of the invention envisions that a protective film is supplementally supplied on the free outer side of the thermoplastic film, that this is conveyed to the support fiber tissue, and during the heating and cooling process is surfaced bonded therewith, preferably releaseably, under the influence of the pressure force. The protective film can likewise be drawn from a supply roll and, together with the thermoplastic film and the support fiber web, be conveyed to the pass-through segment. A preferred embodiment of the invention envisions that the support fiber web, the at least one thermoplastic film and the, in certain cases present, at least one protective film are pressed, heated and cooled between the revolving bands or belts of a double band press. The protective film comprised preferably of a non-melting plastic material ensures that the press apparatus, during the heating process, does not come into contact with the melting thermoplastic

material and become soiled therewith. The protective film can be pulled off from the finished flat strip after the pass-through segment, and be rolled onto a separate film roll, for example for reuse. On the other hand, it is possible to leave the protective foil on the finished flat strip and to pull it off at the point of use.

The flat strip can be rolled onto a material roll after the pass-through segment. It is also possible to separate the flat strip into narrower strips with predetermined breadths parallel to the direction of passage, after the pass-through segment, and in certain cases to roll these narrower strips upon a material roll. It is further possible to store the, in certain cases stripwise-separated flat strips, with formation of flat strip lamella or stack in segments of predetermined length.

The above-described first inventive variant has the advantage, that therewith any of various thicknesses of flat strips can be produced. The thermoplastic film need merely be adjusted in its wall thickness to conform to the thickness - and therewith the receptivity - of the reinforcing fiber web.

A further inventive variant, which is above all suitable for manufacture of thin flat strip bands, envisions that the support fiber web is soaked with a preferably aqueous suspension of finely distributed thermoplastic synthetic material particles, that the soaked support fiber web is subsequently dried under the influence of heat, that the thermoplastic material deposited upon the support fiber web is then caused to melt under the influence of heat and then cooled again with formation of solidified binder matrix. Advantageously, the support fiber web drawn off of the roll is conveyed through a suspension mixture and subsequently through a vaporization segment, a melting segment and a cooling segment. The support fiber web can in addition be pressed or

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calendared prior to, during or after the solidification of the binder matrix. The flat bands produced in this manner can be surface bonded into multiple layers under the influence of pressure and heat.

The flat strips produced in accordance with the inventive process exhibit a plurality of parallel oriented reinforcing fibers, which could be interwoven with transverse fibers for formation of a support fiber web, and which together with the transverse fibers are embedded in a binder matrix of thermoplastic material, wherein the binder matrix penetrates the free interstitial spaces of the support fiber web. The support fiber web embedded in the binder matrix can have a releaseable protective film provided on at least one broad side.

For the formation of the binder matrix a thermoplastic material could be selected from the group consisting of polyolefins, vinyl polymers, polyamides, polyacetals, polycarbonates, polyurethanes and ionomers. The reinforcing fibers preferably contain carbon fibers or are carbon fibers. The support fibers and the transverse fibers can also be formed of, or contain, aramid fibers, glass fibers or polypropylene fibers.

As protective films one could consider for example a duroplastic synthetic material such as a polyester resin or an elastomeric plastic such as silicon-rubber or silicon paper.

BRIEF DESCRIPTION OF THE DRAWING

In the following the invention will be described in greater detail on the basis of the embodiment schematically represented in the figures. There is shown:

Fig. 1 a flow schematic for the manufacture of a flat strip lamella with utilization of a double band press;

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Fig. 2 a flow schematic for the manufacture of a flat strip lamella using a suspension mixture.

DETAILED DESCRIPTION OF THE INVENTION

The process described in the following is designed for manufacture of flat strips and flat strip lamellas or laminates, which exhibit a composite structure of a plurality of flexible or bendable support fibers oriented parallel to each other, a certain proportion of transverse fibers interwoven perpendicular to the support fibers, and a stabilizing binder matrix of a thermoplastic material. The thermoplastic binder matrix ensures that the flat strip is relatively stiff at the temperature of use and is plastically deformable upon heating to a temperature above the glass transition point.

The arrangement schematically represented in Fig. 1 for manufacture of this type of flat strip includes a double band press **20** with two press bands **24** running in opposite directions over direction-changing rollers **22**, of which the belt sides **26** facing each other define a pass-through segment **28** for a continuous strip **30** to be processed in the below described manner, and which band press presses against the broad surfaces of the continuous strip. For forming the continuous strip **30** a support fiber web **38**, two thermoplastic films **40'**, **40''** and two protective films **42'**, **42''** are drawn off of five supply rolls **32**, **34'**, **34''**, **36'**, **36''** and conveyed, with their broad surfaces contacting, into the inlet side of the direction-changing rollers **22** of the double band press **20** in the shown manner. The continuous strip **30** passes along the pass-through segment **28** with maintenance of the pressure force of the press bands **26**, passing first through a heating segment **44**, along which the thermoplastic

material of the thermoplastic films 40', 40'' is caused to melt and pressed into the free spaces of the support fiber web. The protective films 42', 42'' ensure that the press bands 26 are not contaminated by the melting thermoplastic material. In the further course of the pass-through segment 28 the continuous strip passes through a cooling segment 46, in which the thermoplastic material is caused to solidify with formation of a binder matrix within the support fiber web. Subsequent to the double band press 20 the flat strip produced in the manner can, as shown, be wound upon a roll 48. Alternatively thereto the flat strip can also be separated into strips parallel to the pass through direction, and be rolled onto different rolls or, with formation of flat strip lamellas, be stacked or stored. With the described process it is possible to produce flat strips of various thicknesses as required. In this case it need merely be observed, that the thickness of the thermoplastic films 40', 40'' and therewith the amount of the thermoplastic material available for use, conforms to the thickness of the support fiber web 38 - and therewith the receiving volume in the empty spaces of the web.

The arrangement shown in schematic manner in Fig. 2 is, in contrast thereto, only designed for and suitable for manufacture of relatively thin-walled flat strips. The support fiber web 38 drawn from the supply roll 32 is, in this case, drawn over direction changing rollers 50 through a suspension mixture 52, which is comprised of a preferably aqueous suspension of finely divided thermoplastic plastic particles. The support fiber web 38 is soaked in the mixture 52 of the aqueous thermoplastic suspension and is conveyed as a continuous strip 30 along the pass-through segment 54, first to a vaporization station 56 in

which the water is vaporized under the influence of heat 58 in the direction of the arrows 60 out of the continuous strip 30. Subsequently, the continuous strip 30 passes through the heating segment 62, in which the thermoplastic particles retained in the support fiber band are caused to melt. In the subsequent cooling segment the molten thermoplastic material is caused to solidify to form the binder matrix. In the roller press (calendar) 66 the continuous strip receives its final thickness and is then wound upon a material roll 48. It is also possible in this case to divide the continuous strip, subsequent to the press 66, parallel to the pass-through direction 68, after which it is either wound or stored as flat strip stacks or lamellas.

In summary the following is concluded: The invention relates to a method for producing a flat strip in which a reinforcing fiber fabric, comprised of a multitude of parallel aligned reinforcing fibers that are interwoven with cross-fibers, is embedded in a binder matrix made of synthetic material. According to the invention, the reinforcing fiber fabric 38 is stiffened using a binder matrix made of thermoplastic material and is sealed against liquid penetration. In order to form the binder matrix, the reinforcing fiber fabric 38 can be pressed together with a film 40', 40'' made of thermoplastic material, heated and cooled again. In an alternative embodiment, the reinforcing fiber fabric 38 is firstly impregnated with a preferably aqueous thermoplastic suspension 52, is subsequently heated while evaporating the water and melting the thermoplastic material, and is cooled again to form the solidified binder matrix.